From: Conrad Izatt <conrad.izatt@arup.com>
To: wtc@nist.gov
Cc: dlowe@nist.gov
Subject: WTC Draft Final Report Comment Form for Report: NCSTAR1-2B

Information Submitted on: 8/1/2005.

Name : Conrad Izatt
Affiliation : Arup ATG
Email Address : conrad.izatt@arup.com
Phone : 02077552244
Report Number : NCSTAR1-2B
Page Number : Page 11
Paragraph : Section 2.2.3 Paragraph 1
Comment : The synthetic stress-strain curves were based on several data sources to account for the multiple sources of steel used in the construction of the WTC towers. It would have been more sensible and representative to base the steel material properties on the synthetic stress-strain curves rather than on a set of test results for one particular steel.
Comment Reason : Steel material properties could be more representative of the variety of steels used in the WTC towers.

Revision Suggestion : Explain why the steel material properties were based on a set of test results for one particular steel rather than the synthetic stress-strain curves developed.

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Report Number : NCSTAR1-2B
Page Number : Page 14
Paragraph : Section 2.2.4 Paragraph 1
Comment : The use of Cowper-Symonds parameters to factor the yield-strength is a relatively crude method and (for a particular strain rate) factors the whole stress-strain curve by the same amount. In reality, the strain rate enhancement at a particular strain rate differs along the whole stress-strain curve. If the tests were performed at high strain rates, then stress-strain curves should have been available at these high strain rates. The steel material properties could have been input into the material model as a table of stress-strain curves at different strain rates.
Comment Reason : Steel material strain-rate properties could be modelled more accurately.

Revision Suggestion : Explain why Cowper-Symonds parameters were used instead of using the high strain rate stress-strain curves.

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Report Number : NCSTAR1-2B
Page Number : Page 15
Paragraph : Section 2.2.4 Table 2-1
Comment : It is not clear whether the brick element failure strains quoted in Table 2-1 are applicable to the fine or medium meshes.
Comment Reason : Unclear applicability of brick element failure strain values.

Revision Suggestion : Explain what the brick element failure strains in Table 2-1 are applicable to.

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Report Number : NCSTAR1-2B
Page Number : Page 26
Paragraph : Section 2.4 Concrete Constitutive Models
Comment : There are many constitutive models available in LS-DYNA which can represent concrete behaviour. In addition to the compression behaviour, the tensile behaviour (cracking and fracture) is also likely to be important.
Other concrete material models (such as the Winfrith concrete model □ material type 84) are able to represent the cracking and fracture energy with greater realism than the pseudo-tensor material model.
Comment Reason : Other constitutive models within LS-DYNA may have provided a more realistic behaviour, particularly for tensile cracking and fracture.

Revision Suggestion : Explain with more detail why LS-DYNA material type 16 (pseudo-tensor concrete) was chosen in preference to other available material models.

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Report Number : NCSTAR1-2B
Page Number : Page 26
Paragraph : Section 2.4 Concrete Constitutive Models
Comment : This section does not give any information concerning any aspects of the tensile behaviour of the concrete.
Comment Reason : An important aspect of the concrete behaviour has not been accounted for.

Revision Suggestion : Describe the behaviour and modelling of the tensile aspects of the concrete.

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Report Number : NCSTAR1-2B
Page Number : Page 27
Paragraph : Section 2.4 Concrete Constitutive Models
Comment : The simulation of an unconfined concrete compression test is a very basic test and demonstrates only one aspect of the material behaviour. Concrete material behaviour is complicated and requires many different tests to demonstrate that the material model and parameters adequately represent realistic concrete behaviour in the likely impact conditions.
Comment Reason : The simple unconfined concrete compression test is not sufficient to demonstrate the adequacy of the material model and parameters.

Revision Suggestion : A more rigorous demonstration that the concrete modelling is adequately representative of the concrete behaviour under all of the likely loading scenarios.

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Report Number : NCSTAR1-2B
Page Number : Page 32
Paragraph : Section 2.4 Figure 2-32 Concrete Constitutive Models
Comment : The curve for the strain rate multiplier shown in Figure 2-32 shows a smooth and gradual increase from a strain rate of 0.1/s up to 1000/s. There is much published documentation (including the references quoted in the work) that indicates that the curve is not smooth and gradual, but kinked (little increase up to about 30/s and then increasing above that).
Comment Reason : The strain rate enhancement curve used differs slightly in shape from the more usual and accepted shape.

Revision Suggestion : Explain why the more usual and accepted strain rate enhancement has not been used.

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Report Number : NCSTAR1-2B
Page Number : Page 112
Paragraph : Section 5.4 Floor Assembly Component Analyses
Comment : The plow-type impactor used to test the detailed and simplified floor assembly component models appears to have a predominately cutting action. The impact from an engine is more likely to be a blunt impact.
Comment Reason : The impactor uses a cutting action which is not the same as a blunt impact.

Revision Suggestion : A more rigorous demonstration that the simplified model of the floor assembly adequately captures the impact behaviour of the detailed model for the likely impact scenarios.

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Phone : 02077552244
Report Number : NCSTAR1-2B
Page Number : Page 112
Paragraph : Section 5.4 Floor Assembly Component Analyses
Comment : The plow-type impactor used to test the detailed and simplified floor assembly component models appears to have a predominately upwards loading action. The impact from an engine is more likely to be a downwards impact.
Comment Reason : The loading direction from the impactor appears to be opposite to the more likely loading direction in the actual impacts.

Revision Suggestion : A more rigorous demonstration that the simplified model of the floor assembly adequately captures the impact behaviour of the detailed model for the likely impact scenarios.

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